
A LABORATORY INVESTIGATION OF MATURATION IN THE CUBAN BURROWING COCKROACH *BYRSOTRIA FUMIGATA* (GUÉRIN)¹

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ABSTRACT

The study was undertaken to provide information on the number of males and females, number of instars, and accumulative instar lengths in the Cuban burrowing cockroach.

Forty-four broods of *Byrsotria fumigata* (Guérin) were reared from parturition to maturity under controlled laboratory conditions. Each cockroach was color-coded with a different color for each instar, and molts were recorded on the day that they occurred. Development time to the adult stage varied from five to eight months. Seven to nine instars were observed, with males having seven to eight, and females having eight to nine instars. There were no significant differences between the total numbers of male and female cockroaches at the adult stage. Descriptive statistics were computed for the data on accumulative length, in days, of each nymphal instar period.

INTRODUCTION

The Cuban burrowing cockroach, *Byrsotria fumigata* (Guérin), has proven to be an excellent laboratory animal in several physiological investigations (Roth and Stay, 1962; Myers and Fisk, 1962; Myers and Retzlaff, 1963), but little is known of its life history and biology (Roth and Willis, 1960). Fisher and Jursic (1958) report that, under laboratory conditions of 27°C and 60% relative humidity, American cockroaches mature in four months. In a similar study, Haskins (1962)

¹Manuscript received December 22, 1966.

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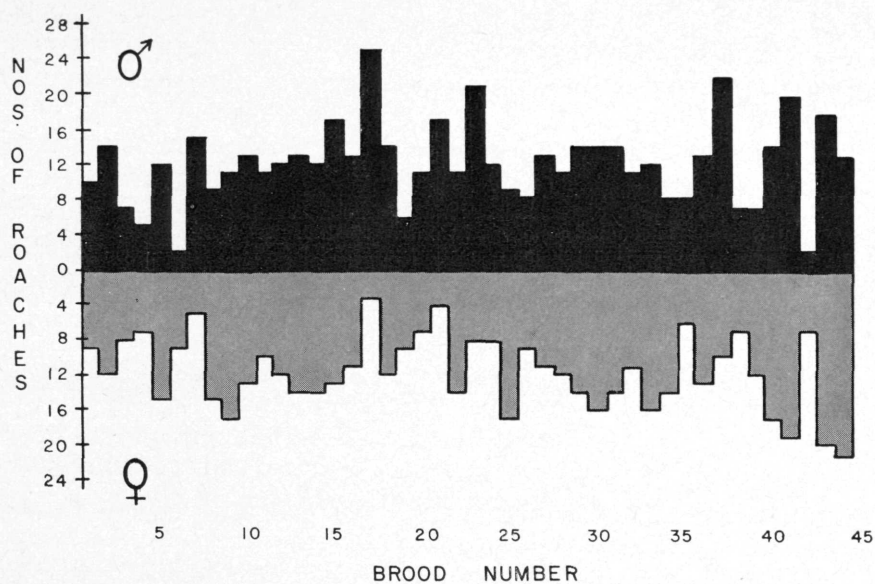


FIGURE 1. Distribution of sexes at maturity.

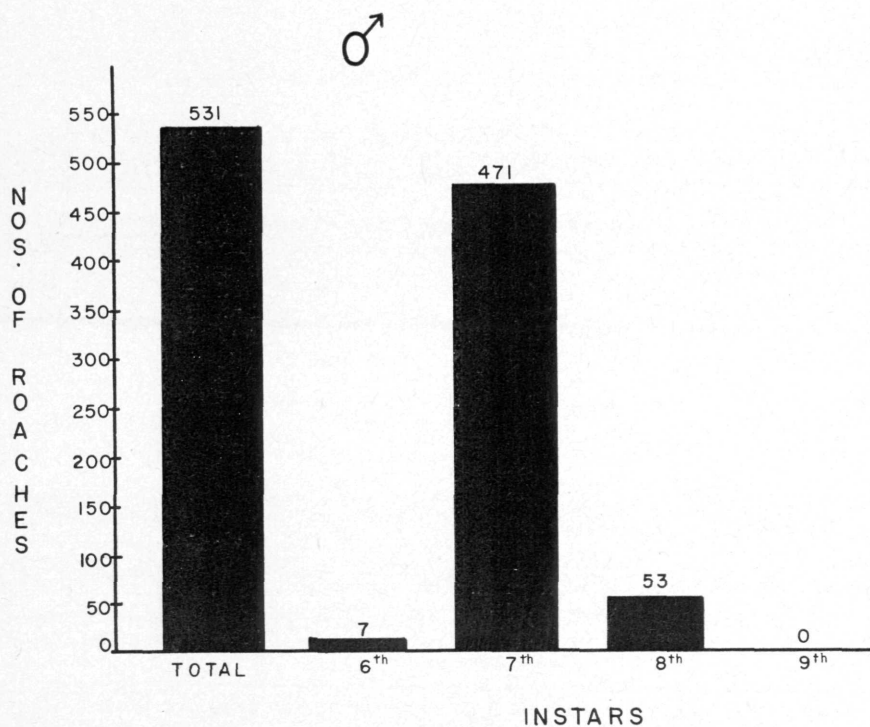


FIGURE 2. Total males and distribution of the number of instars to adulthood for males.

found that, under laboratory conditions of $27.5^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and 30% relative humidity, American cockroaches develop from young nymphs to adults in five to six months. The present study was undertaken to provide information on the number of males and females, number of instars, and accumulative instar lengths in the Cuban burrowing cockroach.

METHODS AND MATERIALS

Plastic refrigerator crispers 14 in. in length, $10\frac{1}{2}$ in. in width, and $4\frac{1}{2}$ in. in height were utilized as cockroach cages. A 4-by-6-in. piece of plastic was cut from the lid, and copper screen was fitted over the hole in the lid to provide ventilation. A soldering iron was used to fuse the edges of the screen to the edges of the hole in the plastic lid. Use of the crispers allowed maximum visibility of the juveniles and prevented escapes during the time the lids were removed.

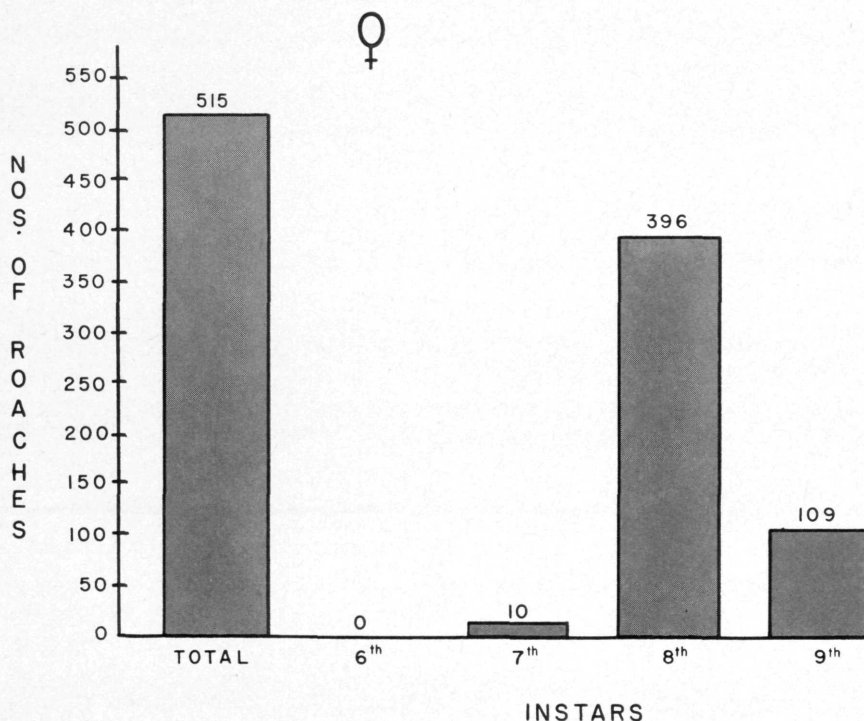


FIGURE 3. Total females and distribution of the number of instars to adulthood for females.

Unlike many other cockroaches, the Cuban burrowing cockroach is ovoviviparous, the female retaining the egg case and bearing live young. Three crispers, containing forty females and ten to fifteen males each, were partially filled with dried, shredded corncobs (distributed as SAN-I-CELL by Laurel Farms, Paxton, Pa.) and used as breeding cages. These cages were checked daily for new-born roaches. Each juvenile cockroach brood was separated from the adults and placed, as a group, in an individual cage for subsequent observation.

Each cage of juvenile cockroaches was supplied with a 4-by-6-in. piece of cardboard to provide a darkened resting area. Water was provided by means of a cotton ball saturated with water. In addition, head lettuce and a prepared high-protein cereal (Beechnut "Hi-Protein" cereal, manufactured by Beech Nut Baby Foods Div., Canajoharie, N.Y.) were supplied daily.

Cages were kept on steel shelving in a rearing room where an ambient temperature of 25–27°C was maintained. A relative humidity of 40–60% was maintained by a humidifier (Oasis, Model OH-100). These environmental conditions were chosen in order to approximate as nearly as possible the natural tropical climate of the Cuban burrowing cockroach. No artificial illumination was provided, because the room contained several large windows. Day-length and crepuscular periods were therefore natural for Ohio.

A series of quick-drying enamel paints (Testor brand) were used to color-code the various cockroach instars. A dot of the appropriate color was placed on the pronotum of the juveniles at parturition and immediately following each successive molt. The cages were checked daily and the number of new molts was recorded.

Free time on the IBM 7094 computer was supplied by the Computer Center of The Ohio State University for the numerical computations and analysis of the data.

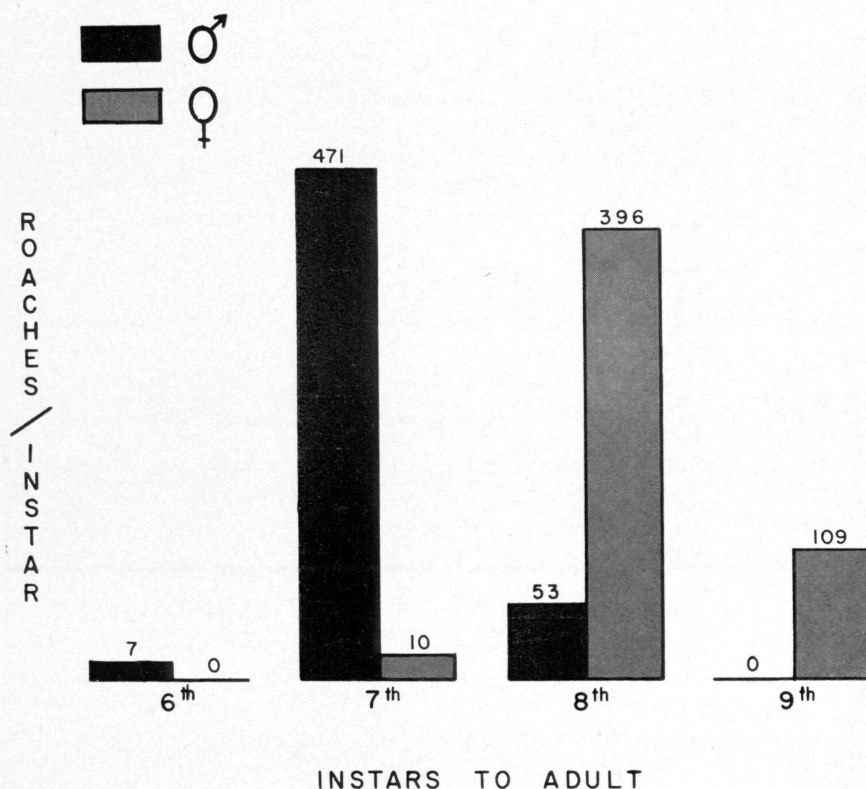


FIGURE 4. Comparison between the distributions of numbers of instars for males and females.

RESULTS AND CONCLUSIONS

This study lasted 21 months, during which time 44 broods, totaling 1046 cockroaches, were isolated and observed while being reared to maturity. The distribution of sexes in each of the 44 broods is shown in figure 1. The relative numbers of male and female cockroaches varied from brood to brood; however, only two broods out of the 44 studied contained significant differences between the numbers of male and female cockroaches (one brood of 28, of which 25 were

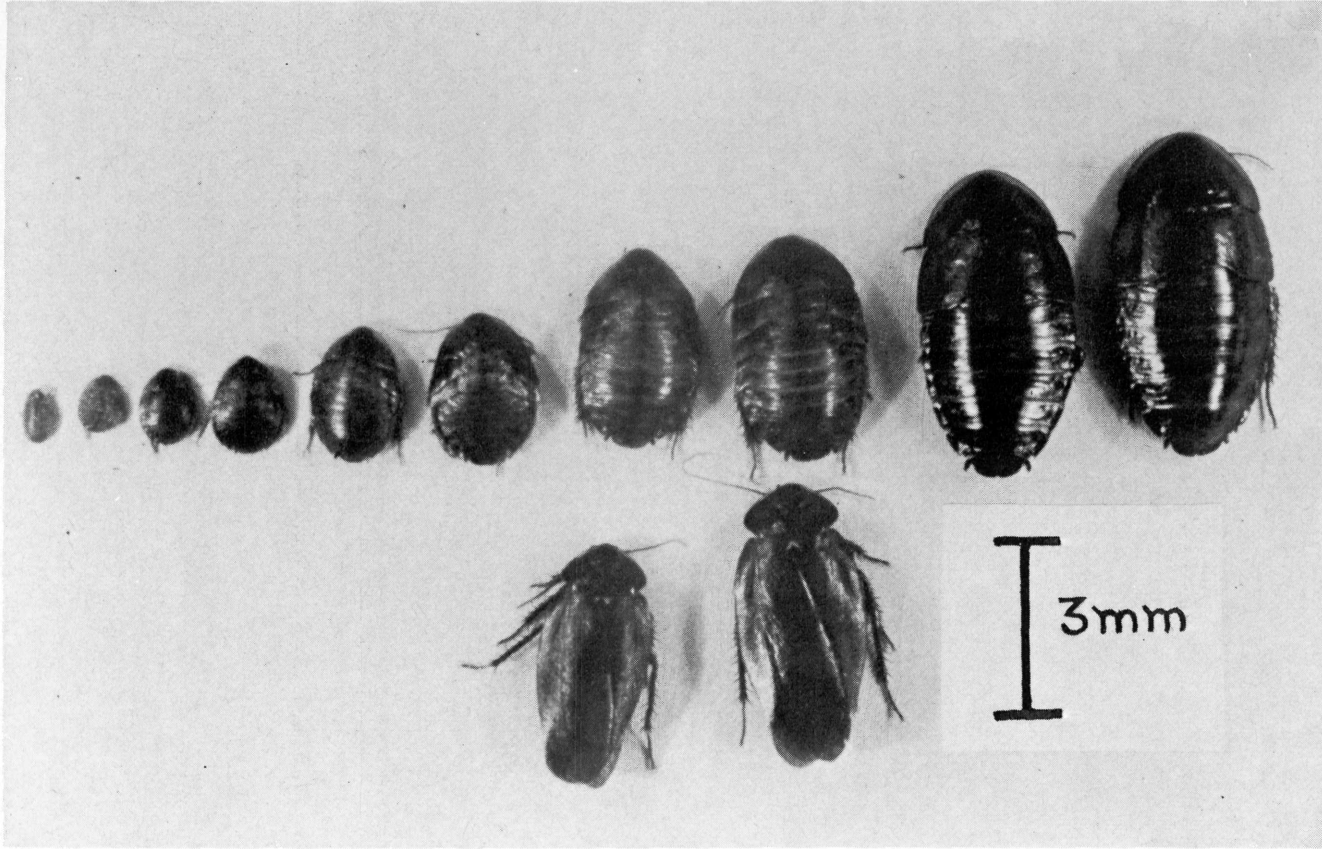


FIGURE 5. Comparison of individual instar size for *Byrsotria fumigata* (Guérin). Adult females at right, top row. Adult males, bottom row.

males, and one brood of 21, of which 17 were males). Of the total of 1046 cockroaches, 531 (50.8%) were males and 515 (49.2%) were females. These data suggest that the two sexes occur with equal frequency at that stage of development when the cockroaches were classified as to sex in these investigations.

As shown in figure 2, considerable variation was also present in the total number of instars which were observed preceding adulthood. Adult males (fig. 2) emerged after six, seven, and eight instars. Of the total of 531 males, 7 individuals (1.3% of all the males) reached adulthood after six instars, 471 (88.7%) after seven instars, and the remaining 53 (9.9%) after eight instars.

Adult females (fig. 3) emerged after seven, eight, and nine instars. Of the total of 515 females, 10 individuals (1.9% of all the females) reached adulthood after seven instars, 396 (76.8%) after eight instars, and the remaining 109 (21.1%) after nine instars. The Kolmogorov-Smirnov test (Siegel, 1956) indicated a significant difference between the distributions of numbers of instars between the sexes. Figure 4 shows that females required one more juvenile instar than males.

A visual comparison of individual instar size illustrates a gradual increase in size with age (fig. 5). Adult sizes appeared to vary directly with the number of instars preceding maturity.

Descriptive statistics involving accumulative number of days spent in each instar were computed from the frequency-distribution data which were gathered at the end of each instar in each cage. For each instar, comparisons were made between cages to estimate a single mean and standard error for the largest group of cages whose individual means did not differ significantly from each other. These statistics are listed in Table 1, and would form a necessary adjunct to the design of experiments involving these cockroaches.

TABLE 1

Sample statistics for accumulative length of time, in days, from hatching to end of nymphal period

Instar	Sample mean	Standard error	Sample size
1	24.19	0.86	915
2	48.28	1.52	945
3	74.19	2.02	844
4	99.30	2.52	881
5	127.60	3.53	982
6	157.87	4.43	990
7	192.79	8.56	610
7-Male	198.99	7.46	388
8-Male	221.51	10.29	35
8	232.35	16.41	113
8-Female	238.22	4.96	342
9-Female	279.08	9.46	94

In summary, the data from this research indicate that the relative numbers of males and females are equal and that females reach adulthood one molt later than males. Adult size seemed to vary directly with the number of instars preceding adulthood, with male roaches reaching maturity after seven instars (an average of 199 days or 6.6 months), and females reaching maturity after eight instars (an average of 238 days or 7.9 months).

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